HEAT TRANSFER FROM A SPHERICAL REACTOR

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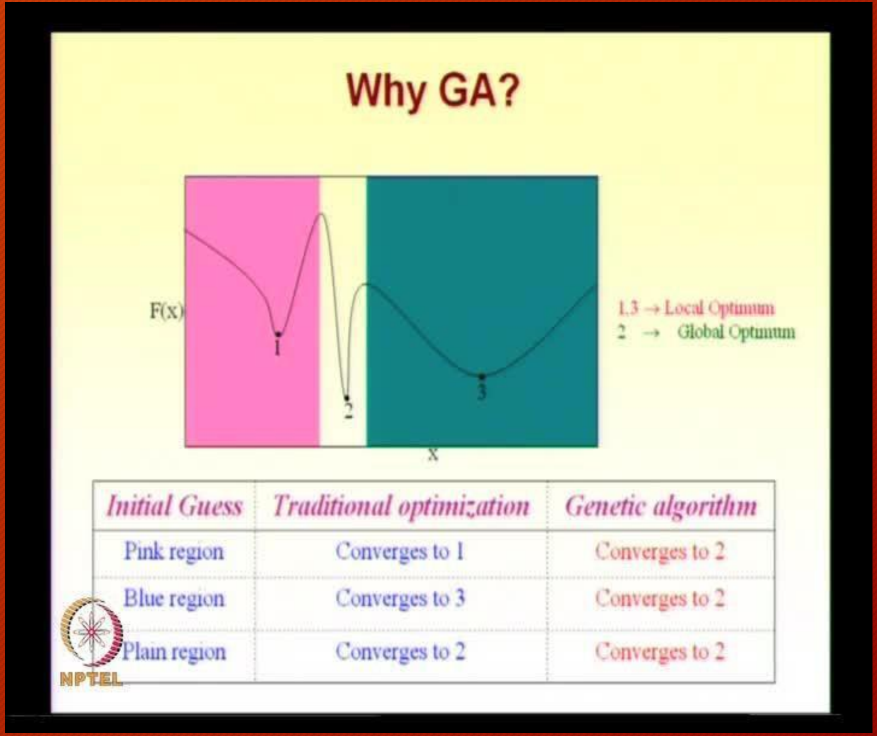
GENETIC ALGORITHMS

- Search algorithms based on the mechanics of natural selection and genetics
- Based of Darwinian theory – survival of the fittest , it simulates evolution for optimization
- **Robustness** – balance between efficiency and efficacy is more important than finding the optimal value
- GA can be applied to a varied number of problems to incorporate robustness in engineering problems

WHY GA ?

- GA’s are more likely to find global optimum
- Best when there many local minimums
- Can be applied to huge data
- Supports multi-objective optimization
- No examples are required to learn and gets better with time
- Obtain good solutions quickly



Source : NPTEL

PROBLEM STATEMENT

The heat transfer Q for a spherical reactor of diameter D is given by the equation :

Q = hTA ------------- 1

where

h -> heat transfer co-efficient

T -> temperature difference from the ambient

A-> surface area of sphere given by πD^{2}

To find the diameter for the minimum heat transfer for a spherical reactor using genetic algorithms

Converting it to a single variable equation by applying the constraint:

The strength equation is DT = 20

This is due to the material limitations

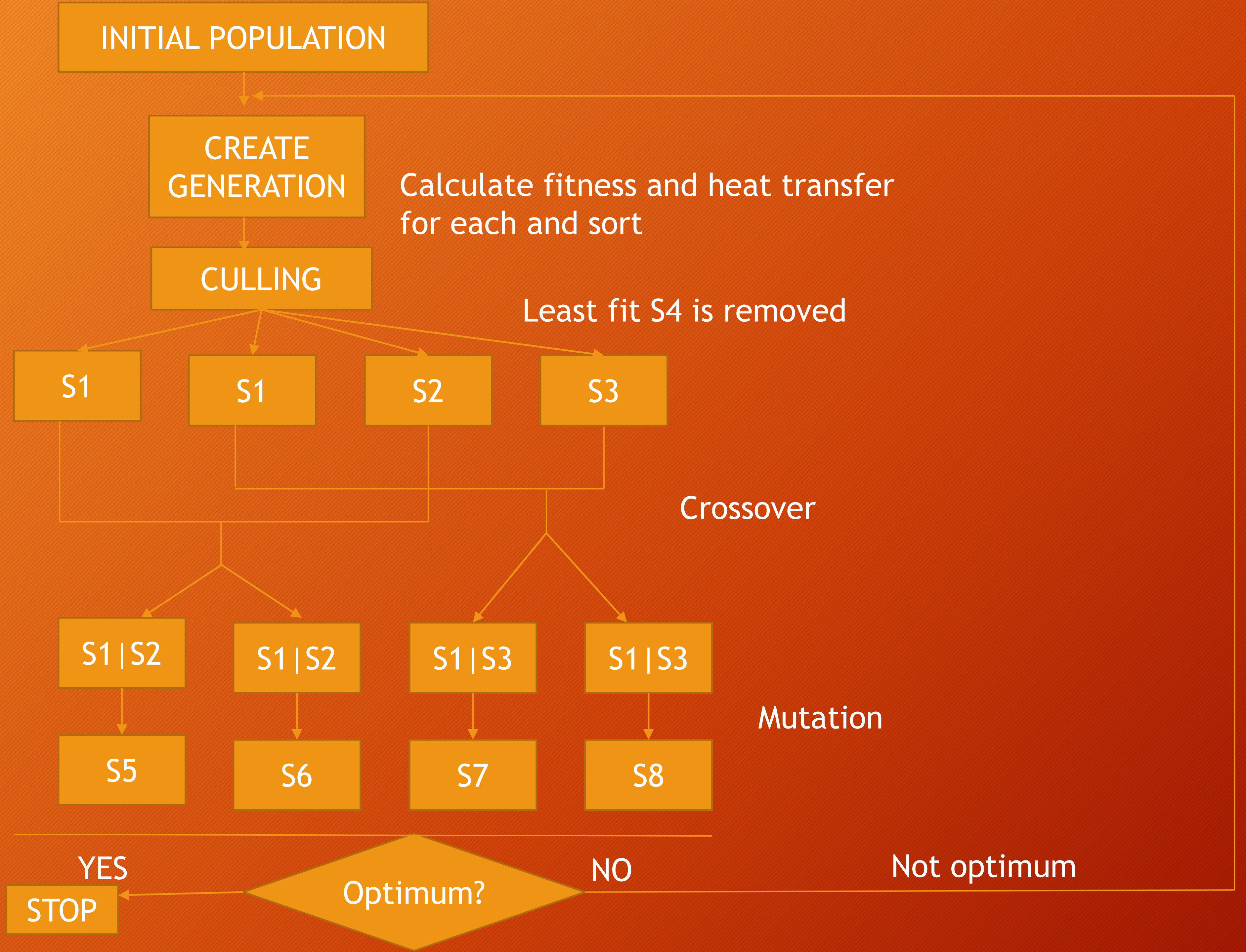
Applying this in 1 we get:

$$Q = 62.83(2D + 0.91D^{-0.2})$$

The first term increases and the second decreases with increase in D value

Goal is to find the optimum value of D to obtain minimum Q

FLOWCHART


INITIAL POPULATION
CREATE GENERATION
Calculate fitness and heat transfer for each and sort
CULLING
Least fit S4 is removed
S1
S1
S2
S3
Crossover
S1|S2
S1|S2
S1|S3
S1|S3
Mutation
S5
S6
S7
S8
YES
STOP
Optimum?
NO
Not optimum

FITNESS FUNCTION

For various combinations of D , Y does not exceed 850 . So problem is converted to maximizing problem as below:

$$Y = 850 - Q$$

POPULATION AND CULLING

Based on relative fitness, the top diameter is considered twice for the next generation . The next two fit specimens are considered once each while the least fit specimen is killed

Therefore 25% of a generation is culled

CROSSOVER AND MUTATION

- Both crossover and mutation is done for optimum results

- After culling and selection of parents as described in previous slide , crossover is performed where first three digits are selected from one parent and the next three from the other parent

- Mutation is done by shuffling the digits

CONCLUSION

The optimum solution for heat transfer is found to be 103 watts for diameter 0.65 using calculus.

We observe that the genetic algorithm applied to this problem performs really well and gives us the optimum D value as 104 Watts (850-746), very close to solution obtained by calculus